RADIOLOGICAL & FUNCTIONAL OUTCOME OF RETROGRADE NAILED HUMERAL DIAPHYSEAL FRACTURE

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CERTIFICATE

This to certify that the dissertation entitled **"RADIOLOGICAL & FUNCTIONAL OUTCOME OF RETROGRADE NAILED HUMERAL DIAPHYSEAL FRACTURE"** is a bonafide record work done by **DR. K. MUTHUKUMAR** in the Department of Orthopaedic surgery, Govt. Rajaji Hospital attached to Madurai Medical College, Madurai, under the guidance of **Prof**. **Dr.V.PANDIARAJAN M.S. Ortho** and overall guidance of me.

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INTRODUCTION

Of all fracture of upper limb, the fracture shaft of humerus is relatively common and easiest to treat. Fracture shaft of humerus accounts for 1% of all adult fractures **(Beaty 1999, Zuckerman1996)** There is wide array of good options for their treatment and there is controversy over best methods for many situations. Appropriate decision making for non-operative or operative treatment depends on a thorough understanding of regional anatomy, fracture pattern (personality of fracture), Classification and finally factors unique to patient (Personality of patient).

Though various modalities of treatment are present-recent advances in fracture management have taken away problems of hanging cast and U slab and Inter Locking Nails have made internal fixation much easier than open plating. **Springer Berlin** had reported 90% to 98% of conservatively treated patients with good results. But nowadays patients demand comfort, early mobilization, and getting back to work as early as possible & will not agree to any shortening or mild deformity. Conservative treatment of fracture shaft of humerus is indicated in undisplaced or minimally displaced short or long oblique fracture without radial nerve palsy or vascular compromise. Moreover the patients with fracture shaft of humerus are often associated with lower extremity or pelvic fractures making conservative management difficult. So, the indication for operative management has considerably increased today.

AIM

To study and analyse radiological union, functional outcome and complications of retrograde unreamed intramedullary interlocking nailing for treating acute humeral diaphyseal fractures in adults.

ANATOMY

The shaft of the humerus lies between the upper border of the pectoralis major insertion proximally and the supracondylar ridge distally. This region encompasses the middle 3/5 of the entire humerus. Proximally, the anterior portion of the greater tuberosity extends into an anterior ridge that ends at the coronoid fossa distally. The posterior aspect of the greater tuberosity continues distally as a lateral ridge that ends in the lateral supracondylar ridge. The lesser tuberosity joins into a medially located ridge that forms the medial supracondylar ridge distally. The deltoid tubercle forms a lateral prominence just proximal to the mid shaft.

Cross-sectional shape varies from round proximally to triangular in the distal shaft. Thus, the humerus presents in the shaft a posterior, an anterolateral and an anteromedial surfaces.

Proximally; the **canal of the humerus** opens widely, but distally it narrows progressively to end in a blunt terminus proximal to the olecranon fossa. Cadeveric studies show that the canal begins narrowing 3 cm proximal to the superior edge of the olecranon fossa and fills with dense bone 1.5cm above the fossa. This is in marked distinction to the medullary canals of lower extremity and has important implications for intramedullary fixation.

Fascial septa divide the brachium into anterior and posterior compartment.

The triceps muscle dominates **the posterior compartment**, the long and lateral heads form the more superficial muscle bellies and overlie the medial head. The radial nerve enters the posterior compartment inferior to teres major and travels on the deep surface of the triceps muscle along the interval between long and lateral heads. (Willioms 1989) Through most of its course in the posterior compartment, the nerve is separated from the bone by 1 to 1. 5 cm of muscle, lying directly against the humerus for only a short distance near the supracondylar ridge. The radial sulcus also contains the nutrient foramen at its midpoint. The **anterior compartment** contains the flexors of the elbow, biceps brachi, brachialis, and the coracobrachialis. The brachialis receives dual innervations from the musculocutaneous and radial nerves.

Interesting relationships exist between the neurovascular structures of the brachium and the fascial compartment. The brachial artery and musculocutaneous and median nerves all reside strictly within the anterior compartment. The ulnar nerve originates in the anterior compartment but then passes into the posterior compartment in the distal arm. The radial nerve has an opposite course by passing from the posterior compartment into the anterior compartment in the distal brachium.

Distal interlocking screws inserted from lateral to medial place the radial nerve at risk, whereas anterior – to – posterior screws threaten damage to the musculocutaneous nerve.

Rotator cuff tendons surround the proximal humerus. The supraspinatus tendon crosses the humeral head superiorly to insert into the superior aspect of the greater tuberosity. For direct access to the humeral canal along the axis of the bone, violation of the supraspinatus tendon must occur. The tendon in its terminal fibres becomes relatively avascular and has poor healing potential. This has important implication for intramedullary fixation from a proximal entry portal.

The axillary nerve lies near the posterior humerus and exists as one main trunk as it exits the quadrilateral space in the posterior upper brachium. Because it does not branch into its many fibres for quite some distance complete paralysis of deltoid may occur if the nerve is injured in this region. An interlocking screw place obliquely from superolateral to inferomedial may threaten this nerve as the humerus internally rotates if the screw penetrates even slightly the medial cortex of the humerus.

MECHANISM OF INJURY
AND
BIOMECHANICS

Klenerman divided the mechanisms by which humeral fractures occur into three separate groups.

I Direct force

II Indirect violence

III Muscular violence

IV High energy direct blow

I **Direct** force implies an impact between the arm and an object, creating a three point bending moment. This occurs when the patient falls against or is thrown against a fixed object or when a blunt object strikes the arm.

This produces transverse type of fracture line.

II Indirect violence in which the energy absorbed by the humerus is applied through the distal portion of the limb.

Example

Violent twisting of the arm behind the back or during arm wrestling.

This mechanism produces spiral type of fracture line.

III Muscular violence

Example in activities such as throwing a base ball

Spiral type of fracture occur

IV Gun-Shot injuries

"High energy direct blow" from a small projectile causes a highly comminuted fracture.

Certain predictable deformities result from muscle forces acting on fracture fragments.

i) With fracture site, above the insertion of pectoralis major, the proximal fragment is abducted and externally rotated by rotator cuff muscles.

ii) Fracture site between pectoralis and deltoid insertion, proximal fragment displaces medially through the pull of pectoralis muscle.

iii) Fracture site below deltoid insertion proximal fragment gets abducted by deltoid and varus deformity at fracture site.

DIAGNOSIS

- Symptoms of a humeral shaft fracture are similar to those of any long bone fracture.
- Pain at the fracture site and skeletal instability

Clinical evaluation of arm reveals

1. Bony tenderness is present
2. Swelling
3. Often visible deformity
4. Crepitus may be noticed, should not be sought
5. Skin should be visualised circumferentially
6. Vascular status should be evaluated
7. All peripheral nerves with careful documentation of radial nerve evaluation because the incidence of radial nerve injuries is approximately 16% (Harstock 1999)
8. Associated skeletal injuries should be assessed.

Imaging studies:

Radiographic assessment includes AP and Lat view of the diaphysis and as well as views of elbow and shoulder joints. To obtain these radiograph, the patient should be moved rather than rotating the injured limb. Traction radiograph may be helpful with comminuted or severely displaced fractures, and comparison radiograph of the Controlateral side may be helpful for determining pre-operative length (Beaty 1999, Zuckerman 1996)

CLASSIFICATION OF HUMERAL SHAFT FRACTURES

AO/ASIF Classification of humeral shaft fractures – based on fracture comminution

Type A - Simple (Uncomminuted)

Type B - have a butterfly fragment

Type C - Comminuted

Acute humeral fractures are further classified based on classification recommended by the AO-ASIF Group.

A Simple fracture

A1 Simple fracture, Spiral

1. Proximal Zone
2. Middle Zone
3. Distal Zone

A2 Simple fracture, Oblique (>=30°)

1. Proximal Zone
2. Middle Zone
3. Distal Zone

A3 Simple fracture, transverse (<30°)

1. Proximal Zone
2. Middle Zone
3. Distal Zone

B **Wedge fracture**

B1 Wedge fracture, Spiral Wedge

1. Proximal Zone
2. Middle Zone
3. Distal Zone

B2 Wedge fracture, bending wedge

1. Proximal Zone
2. Middle Zone
3. Distal Zone

B3 Wedge fracture, Fragmented wedge

1. Proximal Zone
2. Middle Zone
3. Distal Zone

C **Complex fracture**

C1 Complex fracture, Spiral

1. With two intermediate fragments

2. With three intermediate fragments
3. With more than three intermediate fragments

C2 Complex fracture, Segmental

1. With one intermediate Segmental fragment
2. With one intermediate Segmental and additional wedge fragment
3. With two intermediate segmental fragments

C3 Complex fracture, Irregular

1. With two or three intermediate fragments
2. With limited shortening (< 4cm)
3. With extensive shortening (>= 4cm)

TREATMENT OPTIONS

Conservative method

Hanging arm cast - Caldwell et al

Co-aptation splinting or 'U' splinting

Humeral fracture orthosis - Sarmiento et al

Beaty 1999, Klenerman 1966 recommend the following as degree of acceptable deformity

1. 15^0varus / valgus angulation
2. 20^0 anterior / posterior angulation
3. 3 cm of shortening.

Operative method

1. Plate Osteosynthesis
2. Inter locking nailing

   Retrograde and anterograde manner

3. External fixator system

Bandi (1964) first defined clear indications for operative treatment,

Indications :

Definitive	**Relative**
Satisfactory alignment can't be achieved by conservative measures (angulations >15º)	Severe uncontrolled disorder like Parkinson's disease
Poly trauma patients, requiring early mobilization	Patients with trunkal obesity are at increased risk for varus angulation when treated non-surgically.
Segmental fracture **(Foster 1985)**	
Pathological fracture	
Associated with major vascular injury	
Holstein – Lewis type fracture, in which radial N palsy develops after manipulation	
If treatment of associated injuries make bed rest necessary	
Floating elbow **(Beaty 1999, Gregory 1997, Hart sock 1999)**	
Bilateral fractures **(Zuckerman 1996)**	
Open fractures	

Intra medullary nail – treatment of choice

in

1. Poly trauma patients
2. Segmental fracture
3. Severely comminuted fracture
4. Pathological fracture
5. Osteopenic bone
6. Fracture with compromised skin(burns etc)

THE ROLE OF INTRA MEDULLARY NAILING IN FRACTURE MANAGEMENT-conceptual basis

Intramedullary nailing by definition is confined to long bones.

1. ADVANTAGES OF INTRAMEDULLARY NAILING :

- Provides good stability with limited soft tissue dissection and low complication rate, especially when using closed techniques.
- Intramedullary fixation, particularly using cross locking screws, almost completely eliminates the need for external support.
- Preservation of muscle envelope and periosteum around the fracture site
- .Preserves the extraosseous blood supply to bone, enhancing revascularization of the injured bone and promotes periosteal callus formation.
- Lack of injury to muscles enhances the potential for early joint and muscle rehabilitation.
- When the configuration of the fracture provides axial stability, early loading is possible, since it is a load sharing device. This promotes fracture healing, prevents disuse osteoporosis and reduces the effect of stress protection. For these reasons, implant failure is uncommon when compared to plates and screws.

- Removal of intramedullary nail is less hazardous
- Lack of disuse osteoporosis and absence of screw holes near the fracture site reduces the incidence of refracture.

2. LOCKED VERSUS UNLOCKED NAILING

Use of the conventional intramedullary nail is limited to transverse or short oblique fractures of the middle third of femur.

Locking nails enhances fixation that can almost always guarantee against shortening, angulation and malrotation. The holes in the nails act as stress risers and can lead to implant failure, these problems can be minimized by using larger nails, filling all holes with screws, placing the screws far away from the fractures site and by delaying weight bearing. Screw failure is also a concern. Locking screws are specially designed and are stronger than the ordinary cortical screws.

THE VASCULAR RESPONSE OF BONE TO INTERNAL FIXATION

.Healing of long bone fracture is a dynamic process.

Two most important aspects of fracture repair.

1. Mechanical stabilization of the fracture

and 2. Maintenance or restoration of an adequate blood supply

I .NORMAL BONE BLOOD SUPPLY

In general, all long bones have separate, anastomotic metaphyseal and diaphyseal blood supplies. The diaphysis is supplied primarily by one (or) more nutrient arteries, and an extra osseous soft-tissues sleeve provides an abundant source of periosteal vessels that are concentrated around fascial attachments.

Two nutrient vessels supply arterial blood to humerus. The humerus also has an abundant, circumferential extraosseous soft tissue sleeve.

RHINELANDER recognized the direction of normal bone blood flow through the diaphyseal cortex of a long bone as centrifugal, flowing from medulla to periosteum. He described **three functional components** of bone blood supply.

1. Afferent vascular system – carries nutrients and oxygen.
2. Efferent vascular system carries waste products away from the bone.

3. Intermediate vascular system, which function as a connecting link between afferent and efferent systems within cortical bone.

The Afferent vascular system has 3 components.

- Nutrient artery system
- Metaphyseal arterioles
- Periosteal vessels.

1.The principal nutrient artery, traverses the cortex of the long bone, enter the medullary cavity and divide into ascending and descending branches. It give rise to radially arranged lateral conduits, which enter the endosteal surface of diaphyseal cortex and branch off into short segments of ascending and descending para endosteal vessels that parallel the longitudinal axis of the long bone. The lateral conduit arteries and arterioles divides into the ascending and descending furcations after entering into endosteal surface of the cortex, that enter the surrounding osteon.

2 The metaphyseal arterioles

Metaphyseal circulation occurs through concentric arrangement of metaphyseal arteries which enter near the fascial attachments. These arteries also give anastomotic channels to the nutrient artery thereby supplementing the cortical circulation.

3. The Periosteal arterioles supplies outer one thirds of the cortex. Nutrient arteries and periosteal arterioles are able to supplement each other if one of the routes is compromised.

The efferent vascular system:

In the metaphysis multiple veins that accompany the metaphyseal arteries freely drain from the ends of long bone. Diaphyseal bone is drained by efferent venules that connect with periosteal veins.

II. FRACTURE SITE REVASCULARISATION

Fracture site revascularization is possible by a number of modes; periosteal, endosteal, or intracortical revascularization may occur. In addition, a new and transitory extra osseous blood supply may be derived from the soft tissues surrounding the fracture, it serves to nourish the periosteal callus and detached fracture fragments.

Following a fracture there exists a lag time during which the periosteal vessels undergo neoangiogenesis and ingrowth into the endosteal surface of the cortex occurs. In addition to the periosteal neovascularisation demonstrated here, endosteal neovascularisation may also occur. New endosteal vessels traverse the cortex to supply the periosteal surface. Thus the periosteal and endosteal systems supplement each other, not by immediately reversing the direction of their flow, but through revascularization across the cortex of long bones.

The metaphyseal and endosteal diaphyseal vascular systems, although largely independent, are anastomotic and also supplement each other when one of the routes is compromised.

III. FRACTURE HEALING FOLLOWING INTRAMEDULLARY NAILING

The healing patterns following intramedullary nailing depends on type of fracture and the degree of stabilization.

In **simple fractures** without much soft tissue damage reaming and intramedullary nailing is followed by circulatory deficiencies, that extend to the peripheral parts of the cortical bone, at the fracture site the formation of external callus is not impeded.

In more **complex fractures**, the trauma itself produces interruption of the medullary circulation of the intermediate fragments, while the periosteal circulation is generally maintained. Fracture heals by callus formation at the peripheral perfused cortical bone which grows over the fracture gap.

THE EFFECTS OF THE INTRAMEDULLARY REAMING

Intramedullary reaming naturally causes total destruction of the contents of the marrow cavity. (Blood vessels and marrow).

The medullary canal is irregular in both longitudinal and cross sections. For a stable intramedullary fixation a firm fit is needed. The process of reaming produces a large contact area between the nail and the bone, thereby increase the stability of the fixation. Reaming allows insertion of a larger diameter; stronger intramedullary nail and reaming can stimulate fracture healing by providing a source of autologous bone graft from reaming particles at the fracture site.

The damage is essentially caused by the first reaming. Therefore, it is of minor importance how much reaming is performed.

The effects of reaming on bone strength:

Reaming allows for insertion of a larger nail with a large contact area and more secure fracture fixation. But reaming in turn reduces the bone strength. Fortunately, reaming removes the bone which contributes least to its strength (endosteal bone).

Clinical significance:

Reaming and intramedullary nailing produces significant swelling in the surrounding soft tissues. Infection following nailing can lead to osteomyelitis of the entire shaft of long bones. It is for this reason that open fractures should be preferably treated with intramedullary nail, only after the wound heals sufficiently.

Consequence of reaming:

- High intramedullary pressure forces the medullary contents into general circulation which can led to pulmonary micro embolism and circulatory dysfunction.
- Medullary contents get entrapped in the cortical wall which can slow down the revascularization of the cortical bone and disturb healing.

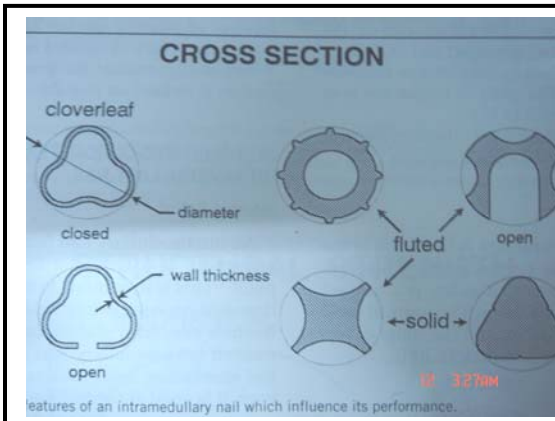
Regarding humerus intramedullary nailing, Russell has reported consistently excellent results with non reamed interlocked nailing. Freedy Achecar of USA indicate that unreamed nailing of humeral fractures is as effective as reamed nailing and he recommends nail insertion without reaming when humeral diameter allows.

BIO MECHANICS OF INTRAMEDULLARY NAILING

INTRINSIC MECHANICAL FEATURES OF AN INTRAMEDULLARY NAIL

Intramedullary nail functions as an internal splint. It has been termed as "a flexible gliding implant". As a gliding implant, the unaugmented nail is not able to control shortening, axial loading or rotation. However, it is good at controlling bending loads.

The geometry of the intramedullary nail is responsible for it's strength, rigidity and fixation with the bone. The major geometric features of nail are **it's cross sectional shape, transverse diameter, slot characteristics, material properties and structural stiffness.**



CROSS SECTIONAL SHAPE

Cross sectional shape of the nail determines its moment of inertia. Combination of moment of inertia with modulus elasticity of the nail, determines its stiffness or flexural rigidity.

SIZE - DIAMETER

Size of the nail also influences the moment of inertia. A smaller nail has a smaller moment of inertia because of it’s dependence of inertia of the 4^{th} power of the diameter. Inertia increased rapidly for each millimeter increase in diameter. Consequently, large diameter nails with same cross sectional shape are both stiffer and stronger than small nails.

SLOT

Most intramedullary nails are hollow except for smallest unreamed nails.

Hollow nails are designed either with open cross sections (i.e., slotted) or with closed cross section (i.e., non slotted). The purpose of a slot in an intramedullary nail is to allow radial compression upon nail insertion, there by accommodating minor bone/ nail mismatch. It’s unknown whether torsional rigidity of a closed section nail is of clinical advantage, because both open and closed section nails yield excellent clinical results.

MATERIAL PROPERTIES

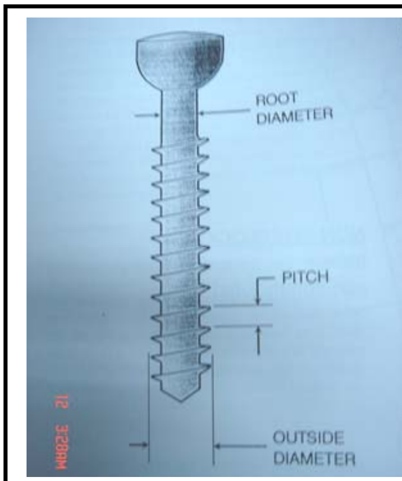
Material properties of an intramedullary nail influences it’s strength and stiffness. Most intramedullary nails are of stainless steel and a few made of titanium. The modulus elasticity of titanium is half of stainless steel and the ultimate strength 1.6 times more.

STRUCTURAL STIFFNESS

As a already mentioned shape and materials of nail, influence strength and stiffness of the nail. For each millimeter increase in diameter, there is an exponential increase in flexural rigidity.

INTERLOCKING NAIL

Interlocking nail introduced in the early 1980's gradually expanded the indication for the intramedullary nailing. The most common means for interlocking are with screws that pass through on cortex. 'Static' nailing refer to the intramedullary nails which are locked both proximally and distally, these nails do not allow gliding of the nail within the bone and control both axial shortening and malrotation. 'Dynamic' nailing refers to nails that have either a proximal or a distal interlock. These nails allow gliding of the nail within the bone.



SCREW STRENGTH

The shape of the thread at their base determines their stress concentrating factor, with a sharp base being more likely to lead to screw breakage than a rounded base.

The strength of the screw is dependent upon the root diameter. A small increase in diameter results in a large increase in strength.

The pullout strength of a screw is dependent upon its outer diameter. A larger outer diameter can engage more bone, and effect a stronger fixation. Similarly when there are more threads which can engage in the bone, the more secure is the fixation.

Why Selected Retrograde Nailing System

Intra medullary nails work well for most long bones including humerus, functioning as load sharing device & subjected to smaller bending loads than plates. The plate sits further from bone's mechanical axis, as is an eccentric extra osseous device precluding weight bearing prior to union. There is less stress shielding of cortex with nails than plates. The risk of stress fracture after implant removal is less with nails. Less dissection is necessary for implant insertion fracture site need not be disturbed directly, but is technically demanding.

Plates carry a significant risk of iatrogenic nerve injury; part with metal removal when there is risk of refracture as well.

This closed technique may result in lower infection rate higher union rate with minimal soft tissue scarring.

Retrograde Inter Locking Nailing – better option

1. Retrograde IL Nailing shows recovery of shoulder function to be complete.
2. Elbow function also, is almost excellent, patients with pathological fracture maintained satisfactory arm function postoperatively
3. Good functional recovery is seen (Clin. Orthop. September 1997. 342).

4. Anterograde inter locking nail gives good results but with more shoulder stiffness and impingement.

I. Nailing

Advantage	**Disadvantage**
Closed procedure, so no soft tissue stripping & disruption of fracture haematoma	Entry point controversy
Blood supply is fairly preserved	Many of our patients have medullary canal < 6.5 mm
Rotational stability is maintained	Radiation hazard
IL Nails is load sharing device	
Implant failure less	
Fixation of choice in osteoporosis bone. osteoporotic bone, pathological fracture, gunshot injury.	
Less risk of radial N palsy	

II. Retrograde Anterograde Nailing

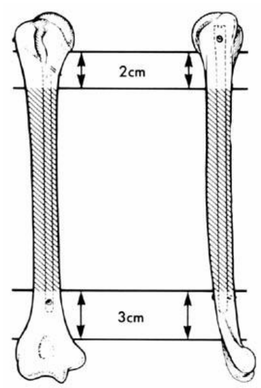
Medullary canal diameter should be ≥7mm enough to allow nail in distal humerus as medullary canal tapers from upward	Shoulder impingement +
Splintering of bone can occur	Rotator cuff Damage

III. Plate osteosynthesis:

Advantage	**Disadvantage**
Anatomical reduction of Fragment	Extensive stripping of periosteum
Radial Nerve Visualization	Infection rate >1-2%
Intra articular extension of fracture can be tackled	Problem in pathological fracture
In vascular injury visualization and repair	In polytrauma and Segmental fracture, not indicated
A load bearing device	

SURGICAL TECHNIQUE – RETROGRADE NAILING

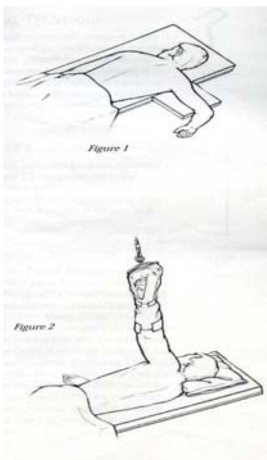
PREOPERATIVE PLANNING



Preoperative radiography of uninjured humerus may be used to estimate proper nail diameter, expected amount of reaming (if necessary), and final nail length for severely comminuted fractures. The proper length and alignment must be attained with traction before initiating closed retrograde intramedullary nailing. If fixed traction is used, it should be intermittent to prevent brachial plexus palsy. The retrograde humeral Interlocking Nailing Technique may be used in patients with proximal third and mid-shaft humeral fractures without disturbing the rotator cuff or the subacromial space. In comminuted fractures, care is taken not to lengthen the humerus while locking proximally and distally. The nail size used depends on the size of the patient and the extent of humeral communication. It is always recommended that the largest implant suitable for the patient be used.

NOTE: Intramedullary nails are not intended to carry significant loads for extended periods of time. Lifting heavy weights beyond knee level and excessive rotation of the elbow should also be avoided. For this reason, patients who are noncompliant, as well as patients who could be predisposed to delayed or nonunion, must have external support.

PATIENT POSITIONING



1.The patient may be placed either prone or in the lateral decubitus position for the retrograde nailing. If the patient is prone, support the fractured extremity by a radiolucent arm board (Figure1).

2. In the lateral decubitus position, suspend the fractured extremity, but take care not to distract the fracture site, as this could lead to neurovascular compromise. Suspension may be aided by an olecranon pin (Figure2).

PATIENT PREPARATION

Scrub and prepare the patient to include the region of the distal clavicle, the acromion, and the medial scapula. The scrub and prep should include all of the arm, the forearm, and the hand. Cover the image intensifier arm with a sterile isolation drape.

APPROACH

Make a longitudinal skin incision, beginning at the tip of the olecranon and extend it proximally about 6 cm. continue the incision through the triceps, splitting it in line with its fibers. Identify and expose the olecranon fossa in the posterior humerus and the region just proximal to the olecranon fossa.

HUMERAL PREPARATION

Figure 3

Figure 4

Using a drill, open the posterior humeral cortex about 2.5 cm proximal to the proximal-most extent of the olecranon fossa (Figure3). Enlarge this hole with a curved Awl or a ronguer to 10 mm wide and 20mm long.

GUIDE ROD INSERTION

Withdraw the curved Awl and insert the 2.0 mm Ball Tipped Reamer guide Rod. Bending the tip of the Guide Rod may aid in reduction. Advance it down the medullary canal. Using image visualization, reduce the fracture and pass the Guide Rod across the fracture site. Confirm presence of the Guide rod in the proximal fragment of the humerus by rotating the image intensifier and the arm internally and externally. Once the Guide rod has been confirmed to be located in the medullary canal of the proximal fragment, pass the guide Rod into the humeral head (Figure 4)

HUMERAL NAIL LENGTH DETERMINATION

Verification of the proper nail length may be determined by **two separate methods**.

1.**Guide Rod Method-** With the proximal end of the Guide Rod in the humeral head, overlap a second Guide Rod extending distally from the humeral entry portal. Subtract the length (X-mm) of the overlapped Guide rod from 700 mm to determine nail length (Figure5).

2.**Nail length Gauge method** – position the Nail Length Gauge anterior to the humerus (unaffected humerus preoperatively; affected humerus intraoperatively) with its proximal end centered in the humeral head. Move the C-arm to the distal end of the humerus and use the image intensifier to read the correct nail length directly from the stamped measurements on the Nail length Gauge (Figure 6).

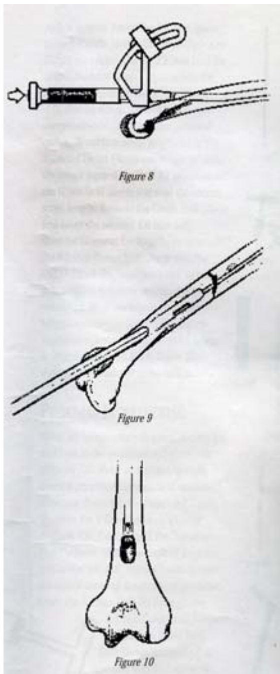
REAMED TECHNIQUE

For a reamed technique, ream the entire humerus over the 2.0mm Ball Tipped Reamer Guide Rod in 0.5mm increments until the desired diameter is achieved (Figure7) The entry portal and 4cm into the canal should be reamed to at least 8-10mm diameter, if adequate bone stock is available. Take care not to penetrate the anterior cortex when first passing the medullary canal of the distal fragment. Ream the diaphysis of the humerus 0.5 to 1.0mm over the selected nail diameter Never insert a nail that has a larger diameter than the last reamer used. Use the Medullary exchange Tube over the 2.0mm Ball Tipped Reamer Guide Rod to Maintain fracture reduction. Replace the 2.0 mm Ball Tipped Reamer Guide Rod with a 2.4 mm Nail Rod. Remove the Medullary Exchange Tube.

UNREAMED TECHNIQUE

For the undreamed technique, Interchangeable sounds can used to determine the diameter of the canal and proper nail In this situation, enlarge the distal Metaphysis of the humerus to 10 mm to open up the Medullary canal. Sounds should be used primarily in open fractures. They are inserted at the fracture site rather than the entry portal. The sounds are inserted over the Guide Rod. The sounds must be inserted manually and NOT DRIVEN. If resistance is encountered, STOP, and withdraw the sound. The largest diameter sound that can pass easily through the isthmus is the correct diameter for the nail.

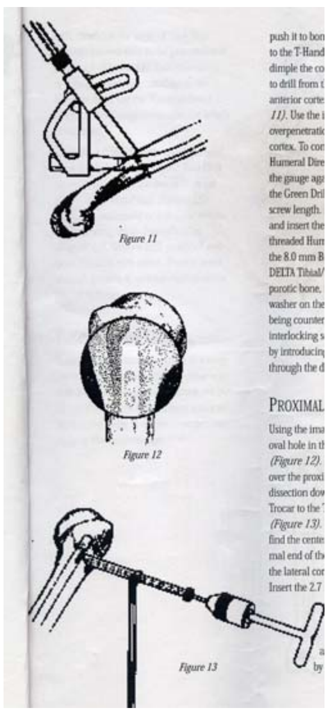
NAIL INSERTION



The 6mm Humeral Nail is not canulated, therefore, the guide Rod must be removed and the 6 mm nail should be inserted under radiographic control without a Guide Rod. **Extreme caution** must be exercised when inserting the nail, as propagation of the entry portal proximally, or **driving the nail out through the anterior cortex of the humerus is possible,** particularly in osteopenic bone. If necessary, with draw the nail & ream the entry portal and distal canal 1to 2 mm more if adequate bone stock is available. Attach the nail to the proximal Drill Guide the proximal Bolt should be tightened onto the nail with the 9/16" Wrench. Attach the Humeral Nail Driver to the proximal bolt. Using the outrigger to control rotation, insert the nail (Figure8) If a Guide Rod is used, gently drive the nail over the Guide Rod to the fracture site (Figure9)At that point, confirm fracture reduction and gently pass the nail across the fracture site to avoid comminution. Remove the Guide Rod after the nail has crossed into the proximal fragment. Confirm containment of the nail within the proximal fragment by rotating the arm and the image beam Drive the nail until its curve, which is facing anteriorly, is buried in the medullary canal of the humerus. **The distal end of the nail**

should be prominent no more than 1cm outside of the medullary canal The proximal end of the nail should end no closer than 2 cm to the subchondral bone, as closer placement would place the proximal interlocking screw in a position where it may impinge in the subacromial space.

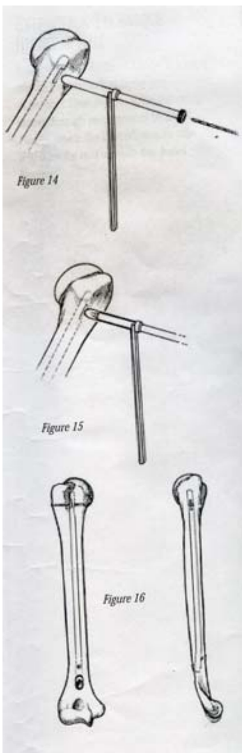
PROXIMAL INTERLOCKING



Using the image intensification, identify the oval hole in the proximal end of the nail (Figure12) Make an incision laterally over the proximal humerus and use blunt dissection down to bone. Attach a 2.7 mm Trocar to the T-Handled Jacob’s chuck (Figure 13) Use the tip of the Trocar to find the center of the oval hole of the proximal end of the nail. Use the trocar to open the lateral cortex of the proximal humerus. Insert the 2.7 mm Drill Bit through the 2.7 mm Green Drill sleeve and 8.0 mm hand- Held Drill sleeve, and insert this assembly into the hole made by the Trocar. Drill parallel to the beam of the image through the oval hole in the proximal end of the nail (Figure 14) Taken care not to drill through articular cartilage in the humeral head. Use the Humeral Direct Measurement Gauge to measure the length of the screw. Insert the 4.0 mm fully threaded humeral screw through the 8 mm Held Drill sleeve, and through the oval hole in the proximal end of the nail (Figure15) confirm containment of this screw within the nail, using image intensification (Figure 16) Irrigate both proximal and distal incisions with saline. Insert a drain through the skin if necessary and close the wound in layers.

DISTAL INTERLOCKING

The R-T Humeral Nail is designed so that, with the retrograde technique, the distal screw is inserted from posterior to anterior and the proximal screw is inserted from lateral to medial. The distal screw is placed using direct vision of the bone (Figure10) Introduce the 8.0mm Green Drill sleeve through the barrel of the proximal Drill Guide and push it to bone Attach the 2.7mm Trocar to the T-Handle Jacob's chuck and use it to dimple the cortex. Use the 2.7 mm Drill Bit to drill from the posterior cortex into the anterior cortex of the humerus (Figure11)Use the image intensifier to avoid over penetration of the anterior humeral cortex. To confirm screw length using the Humeral Direct Measurement Gauge, slide the gauge against the drill Bit and down to the Green Drill sleeve and read the correct screw length. Remove the Green Drill sleeve and insert the selected 4.0 mm fully threaded Humeral locking screw through the 8.0 mm brown Drill sleeve with the DELTA Tibial/Humeral Hex driver. In osteoporotic bone, it may be necessary to put a washer on the screw to prevent it from being countersunk. Confirmation of the inter locking screw within the nail is made by introducing the 2.4 mm Guide rod through the distal end of the nail.



POSTOPERATIVE

Postoperatively, place the patient in a long arm posterior plaster splint and collar and cuff. After two to three days, patients are put in a cast brace if there is concern about stability. Activity range of motion exercises can begin at four to seven days.

EXTRACTION TECHNIQUE HUMERAL NAIL

Extract the R-T Humeral Nail by first applying the Extraction Bolt to the proximal end of the nail. Then remove the interlocking screws through percutaneous incisions. Finally, attach the Driver/Extractor tube and drive the nail out with the slotted hammer.

MATERIALS AND METHODS

Our prospective study was from April 2004 to Feb 2006. At our institution, we selected 19 cases of diaphyseal fractures of humerus for this prospective study. All fresh fractures of the humeral shaft chosen for operative treatment including isolated fractures and those in polytrauma patients were nailed in retrograde manner. When there were no clear indications for operative treatment patients were asked for informed consent for retrograde nailing.

Inclusion criteria

Our patients were selected based upon following criterias.

1. Age more than 17 yrs when the physis is fused.
2. The fracture line is 3 cms beyond the surgical neck of the humerus and proximal to the tip of the olecranon fossa.
3. An angulation of more than 15° after closed reduction,
4. Other associated skeletal injury
5. . Associated neurovascular compromise,
6. Poly trauma
7. The patients not satisfied with POP immobilization or demanding early mobilization

Exclusion criteria

1. The presence of open physis
2. Compound fractures
3. Fractures involving the proximal 3 cms and the distal 1/3 of the diaphysis.
4. On pre operative roentgenogram medullary canal size less than 7mm

All 19 cases were treated with retrograde intramedullary static interlocking nailing. The average age group was 41.15 years The youngest patient in this study was 22 years the oldest was 58 years of age.

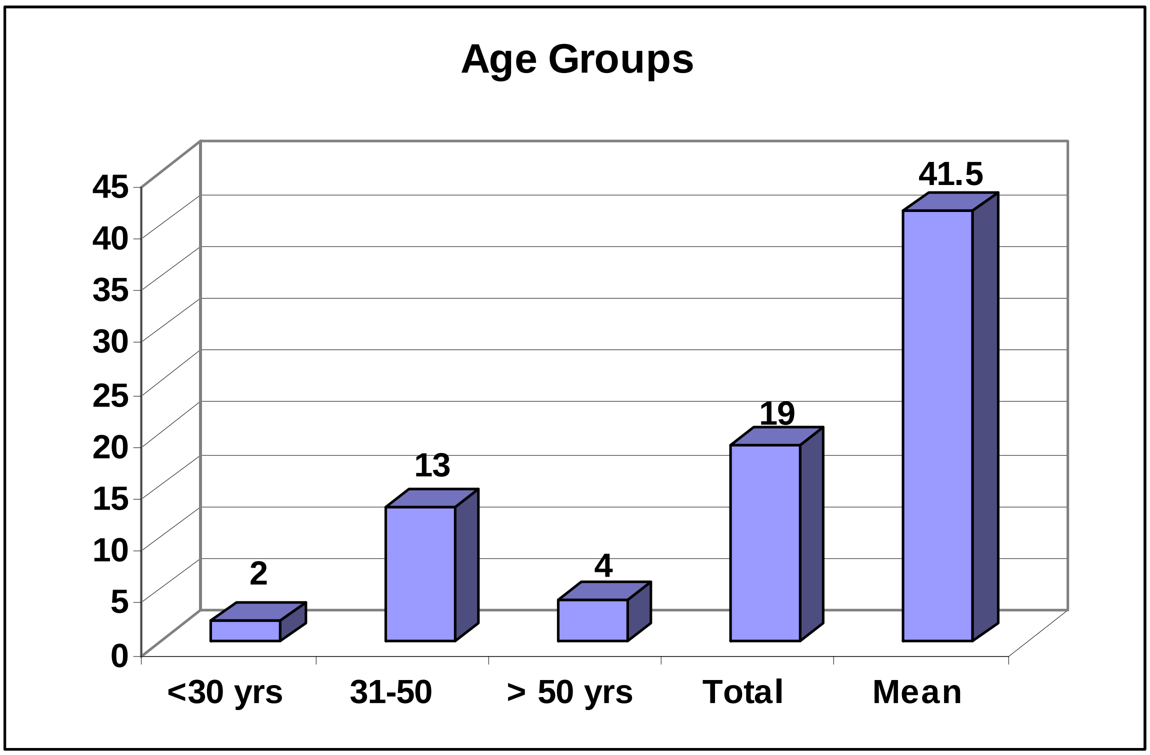
Out of nineteen, 18 were males (94.73%) and 1 was female (5.27%).

89.47% (17 patients) sustained injury due to road traffic accident (RTA),10.53% (2 patients) due to accidental fall

In this study the right humerus were more frequently fractured than the left and middle third fractures were the commonest .

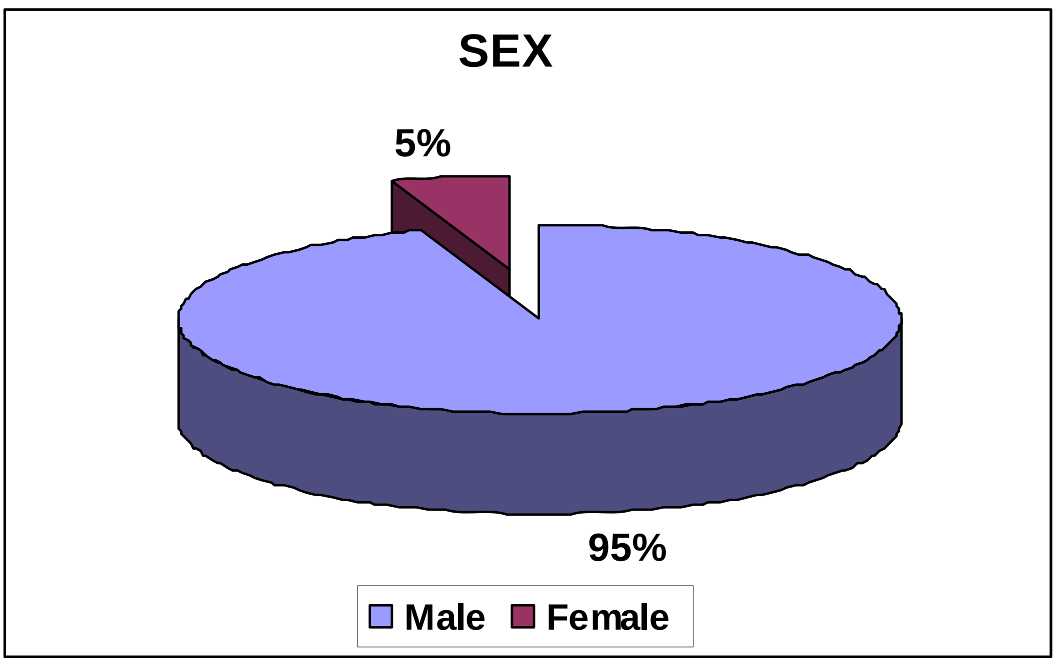
Age

Age group	No	%
<30 yrs	2	10.52%
31-50	13	68.42%
> 50 yrs	4	21.05%
Total	19	100%
Mean	41.5	



Sex

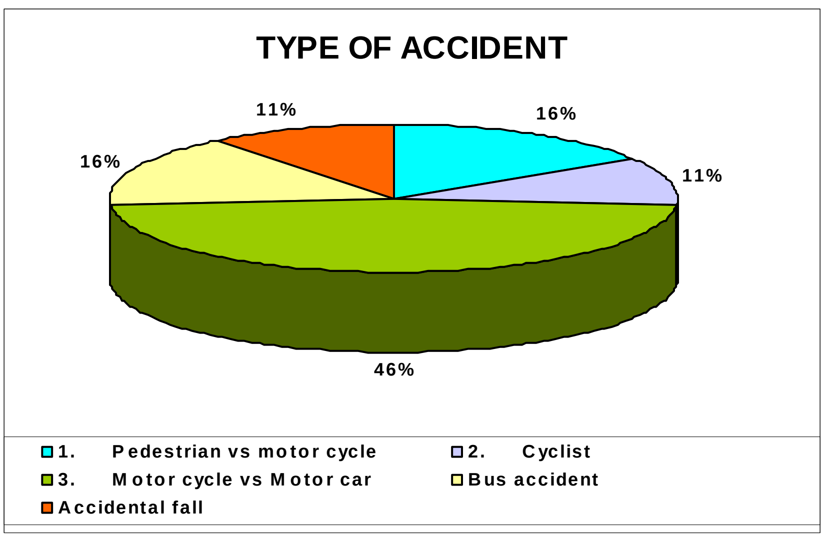
Sex	Retrograde humerus nail	
	No	**%**
Male	18	94.73
Female	1	5.27



RTA is the most common mode of injury that accounts for 17 numbers of patients and rest of the number by accidental fall. (Table1)

Table 1: Mode of Injury

Type of accident	No	Percentage
Road traffic accident **1. Pedestrian vs. motor cycle** **2. Cyclist** **3. Motor cycle vs. Motor car** **4. Bus accident**	3 2 9 3	15.7 10.52 47.36 15.70
Accidental fall	2	10.52
Total No	19	



Fourteen fractures were in category A of the AO classification, three in category B and two in category C.

Table 2 : **Classification**

Classification (AO/ASIF)		Retrograde humerus nailing			
		No	**Total**	**%**	**Total**
A	A1	1	14	5.26	73.67
	A2	3		15.78	
	A3	10		52.63	
B	B1	1	3	5.26	15.78
	B2	2		10.52	
C	C1	1	2	5.26	10.52
	C2	1		5.26	

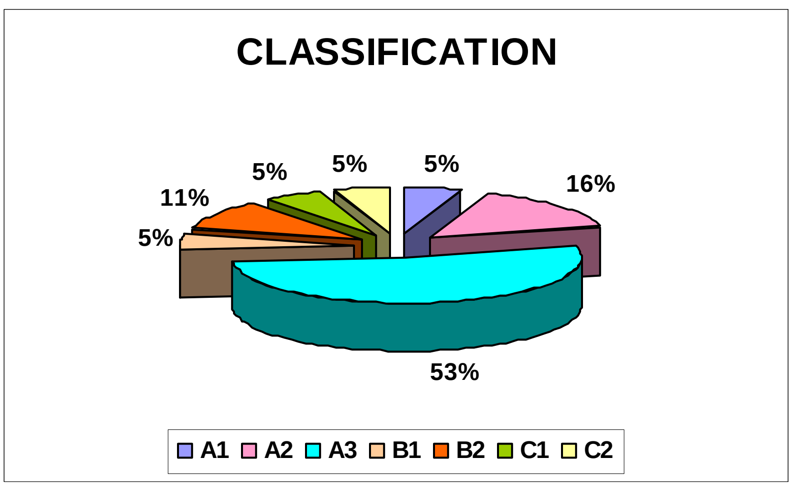
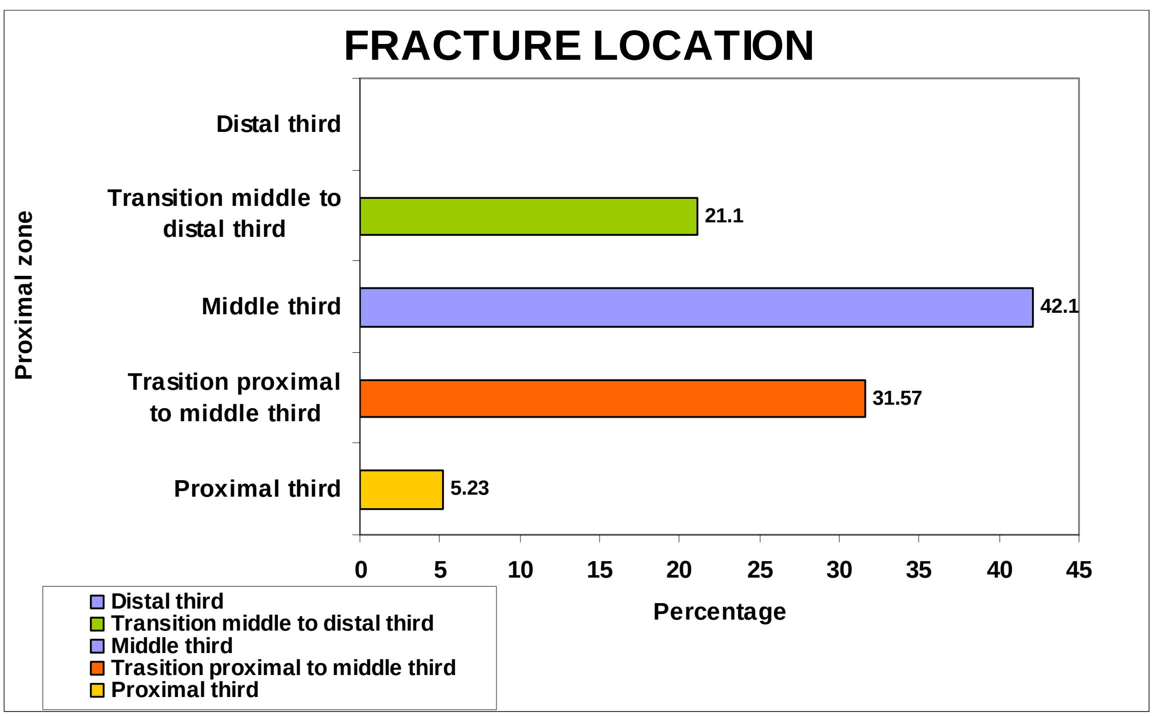


Table 3 : **Fracture location**

Proximal Zone	No	Percentage
Proximal third	1	5.23
Transition proximal to middle third	6	31.57
Middle third	8	42.10
Transition middle to distal third	4	21.10
Distal third	0	



Nine Fractures were transverse, two spiral, three oblique, and one segmental fracture.

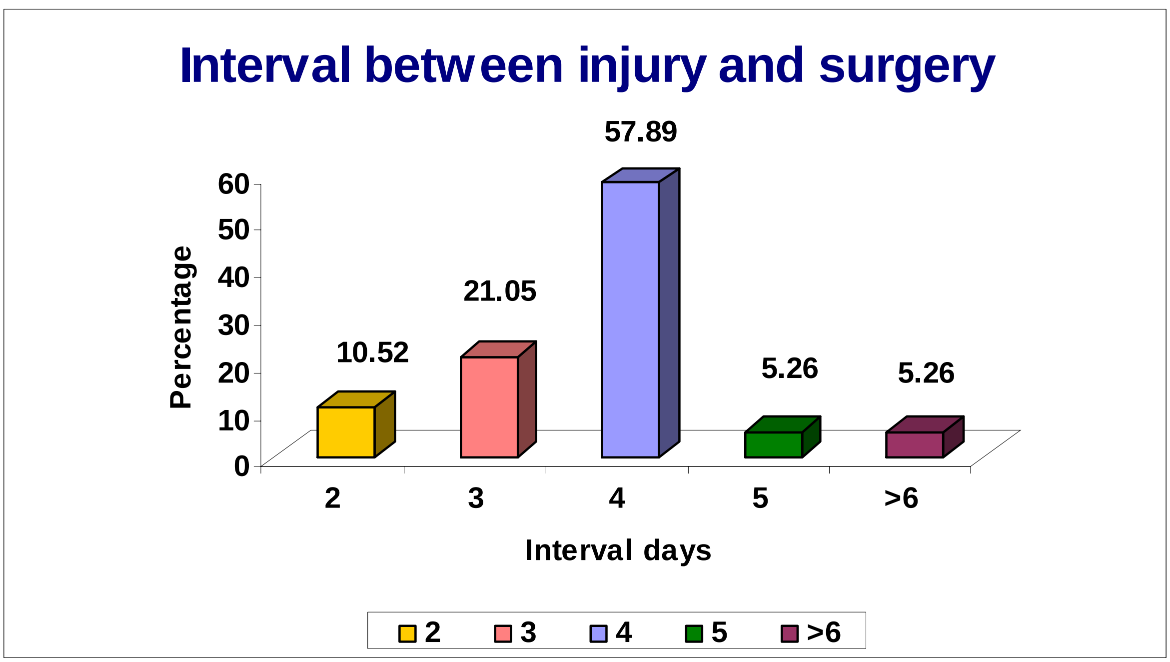
No patient had radial nerve palsy preoperatively.

Nine patients with a solitary fracture and no over-riding indication consented to operative stabilization. 4 had operations because of polytrauma 5 because of failed conservative management, one because of soft tissue damage.

The mean follow-up was 8 months (range 4-12 months). Males were more commonly affected (18 males and 1 female). Right side was affected in 16 and left side in 3 cases. Six patients were sedentary workers and rests were manual laborers.

Interval between injury and surgery

Interval (days)	Retrograde humerus nail	
	No	%
2	2	10.52
3	4	21.05
4	11	57.89
5	1	5.26
>6	1	5.26
Total	19	



Associated injury

One patient had fracture both bone leg ipsilateral side for whom interlocking nail was done.

One patient had bilateral fibula fracture and controlateral humerus fracture with radial nerve palsy for whom open reduction and internal fixation with plate osteosynthesis and exploration of nerve done. Radial nerve was found to be contused and eventually recovered.

One patient had shaft of femur fracture controlateral side for whom interlocking nail was done.

TREATMENT PROTOCOL

More life threatening injuries were looked for and treated immediately. Any neuro vascular involvement, esp. that of radial nerve and the brachial vessels were looked for and ruled out. The humeral diaphyseal fractures are treated with closed reduction and co-aptation splinting. This can be the definitive treatment if the reduction is satisfactory and there are no neuro vascular complications.

Once the patient is stabilized systemically patient is processed for surgery and the preoperative planning is done.

PRE OPERATIVE PLANNING

Initial assessment was done by antero-posterior and lateral x-rays of the affected arm. Any associated injuries were also noted. Appropriate nail size and diameter was determined pre-operatively using x-rays.

The nail size is measured between the tip of the greater tuberosity to a point 3 cms proximal to the tip of the olecranon fossa.

All the cases were immobilized with co-aptation splinting till the patients were taken up for surgery. All the cases were treated by retrograde nailing.

Implants and instrumentation

We used 6 and 6.7 mm non canulated (solid) nail with proximal diameter of 8mm and 3.4mm locking screws of appropriate length.

We used 3.2mm drill bit then, overdrilled by 4.5mm drill bit and finally by 8mm bullet bur for making entry point.

Anesthesia and use of image intensifier

The surgery was done in a standard radiolucent table in prone position with the use of image intensifier. Supra clavicular block anesthesia were given for 16 patients and 3 patients were operated under general anesthesia.

RETROGRADE NAILING

Patient was positioned prone and fractured extremity was placed on a radiolucent arm board and the lower arm hanging down

Entry point

This is the most **critical step** in the nailing procedure. The dorsal triangular surface of the distal metaphysis is exposed. The entry point is located at the centre of this triangle. To have an uncomplicated access to medullary canal, the entry point should be oblique enough and large enough. Three holes are drilled perpendicular to this dorsal surface using 3.2mm drill bit. The holes are over drilled with 4.5mm drill bit. The entry point is then enlarged to a width of 10mm and the length of 20mm using 8mm bullet burr. The angle of the burr axis is decreased progressively while drilling until burr axis is almost in line with the path of medullary canal.

The smallest diameter of humeral nail (6mm) was chosen for most patients. The 6mm humeral nails are solid and are inserted without a guide wire.

After insertion, the nail was locked with two self – tapping screws, the proximal screw was locked first and screw was inserted from lateral to medial side using free hand technique. Distal screw was inserted using the jig attached to nail from posterior to anterior.

Post-operative period

Post-operatively compression bandage and a sling was applied in adduction. The parenteral antibiotics were given for 10 days and wound inspected on 5th day. Suture removal was done between 12th and 14th day.

One week after fixation active - assisted mobilization of the shoulder and elbow is taught and started. Active rotation of the upper arm against resistance is discouraged until callus is visible on radiographs. Patient was then discharged with advises to continue shoulder and elbow exercises.

Follow-up

Patients were followed up at 6 weeks at which time the range of movement of shoulder and elbow was noted. Check X-rays were taken to evaluate fracture healing and implant failure if any. Patients were next called up at 3rd, 6th and 12th months, following surgery. Range of movement of shoulder and elbow are noted and check x-rays were taken.

Radiological union was defined as the osseous bridging of three of the four cortices visible on AP and LAT radiograph

Rehabilitation program

Patient is taught passive and active range of motion exercises for the shoulder and the elbow and he is made to perform the same as the pain permits. Active guided mobilization of the shoulder is essential for better rehabilitation. Progressive increasing weight lifting was promoted with time.

Assessment

We recorded pre operative and post operative problems healing time, and secondary operations.

The functional out come was assessed by the Rodriguez-Merchan criteria.

Functional outcome

The functional results were graded by criteria of Rodriguez-Merchan.

ROM was measured by a single observer by a goniometer

Rating	Elbow ROM	Shoulder ROM	Pain	Disability
Excellent	Extension 5° Flexion 130°	Full	None	None
Good	Extension 15° Flexion 120°	<10% loss ROM	Occasional	Minimal
Fair	Extension 30° Flexion 110°	10-30% loss of ROM	With activity	Moderate
Poor	Extension 40° Flexion 90°	>30% loss of ROM	Variable	Severe

RESULTS

Out of the 19 patients evaluated, we documented

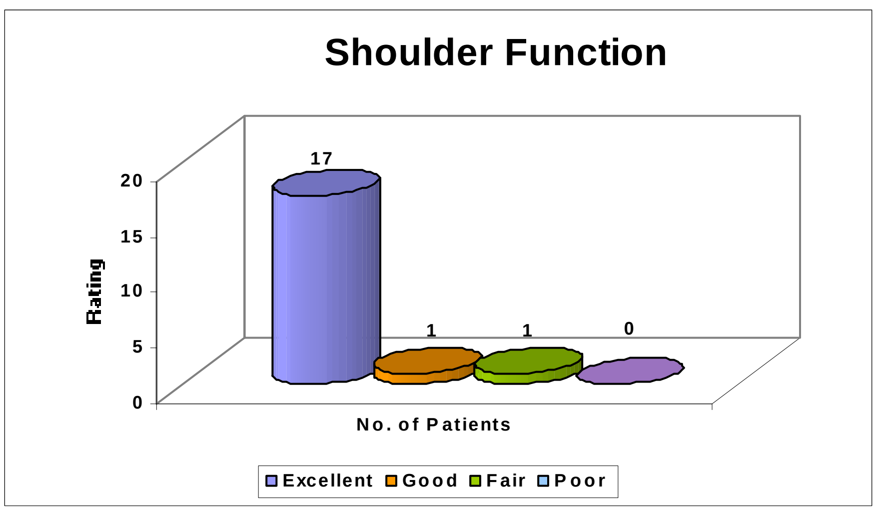
Operating time	58.94 Mts
Image intensifier	54 Sec
Fracture union	13.74 Weeks
Functional grading by RODRIGUEZ MERCHAN CRITERIA	Good to excellent 91.8% Fair to poor 7.8%

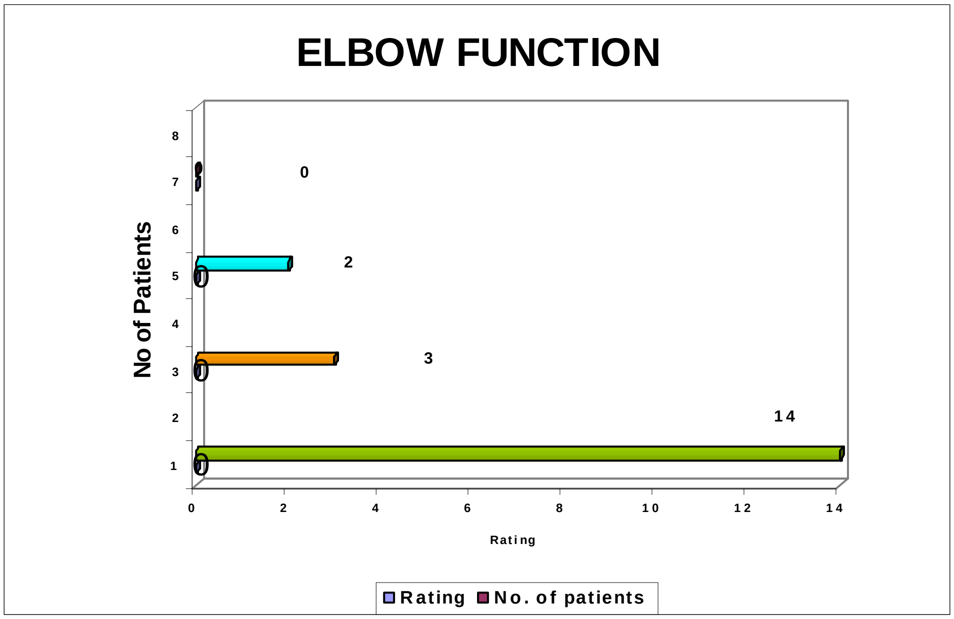
The average hospital stay was 19 days and the mean healing time of a all fractures was 13.74 weeks. Patients with isolated lesions were in hospital for a mean of 14 days.

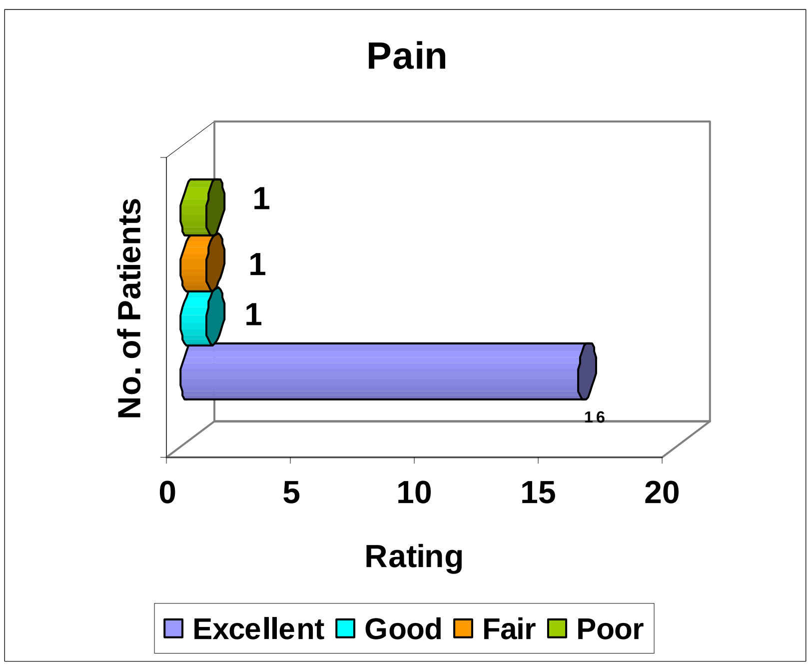
At review, shoulder function was excellent in 17 patients, good in one patient, fair in one patient, no one in poor grade. Elbow function was excellent in 14 patients, good in 3 patients, two in fair grade, no one in poor grade.

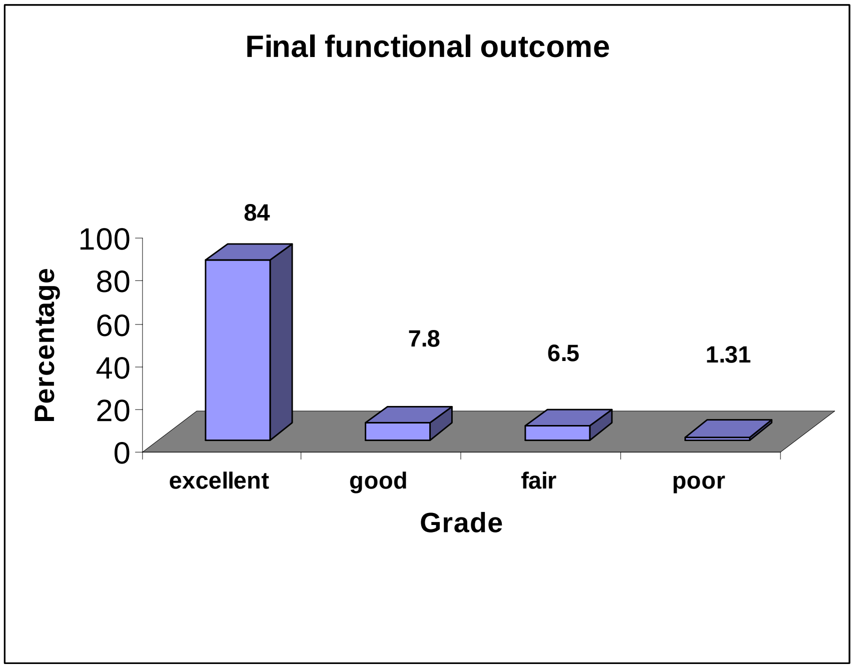
Total functional out come was excellent in 84% patients, good in 7.8% patients, fair in 6.5% patient poor grade in 1.31% patient.

Rating	Elbow ROM	No. of patients	Shoulder ROM	No. of patients	Pain	No.of patients	Dis - ability	No.of patients
Excellent	Extension 5° Flexion 130°	14 (73.68 %)	Full	17 (89.47 %)	None	16 (84.21 %)	None	17 (89.47 %)
Good	Extension 15° Flexion 120°	3 (15.78 %)	<10% loss ROM	1 (5.23%)	Occasional	1 (5.23 %)	Minl	1 (5.23 %)
Fair	Extension 30° Flexion 110°	2 (10.52 %)	10-30% loss of ROM	1 (5.23%)	With activity	1 (5.23 %)	Moderate	1 (5.23 %)
Poor	Extension 40° Flexion 90°	-	>30% loss of ROM	-	Variable	1	Severe	-




ELBOW FUNCTION
No of Patients
8
7
6
5
4
3
2
1
0
2
3
14
0
2
4
6
8
10
12
14
Rating
Rating
No. of patients


Pain
No. of Patients
1
1
1
16
0
5
10
15
20
Rating
Excellent
Good
Fair
Poor



Fracture union (in weeks)

Time (in weeks)		
	No	**%**
≤ 10	1	5.23
10 – 15	7	36.84
15 – 20	10	47.36

In our series, union was noted in 18 out of 19 cases of fresh fractures of the humeral diaphysis. One patient went for non union. Respective patient was obese individual, smoker, hypertensive and diabetic on drug treatment he was a poor attender of follow up program FOR him nail exit is done, and internally fixed with plate osteosynthesis and bone grafting.

The average time for union was 13.74 wks for all acute cases.

COMPLICATIONS

Postoperatively, there was iatrogenic radial nerve palsy in one patient (5.23%), which fully recovered in three months.

There were no infections or vascular problems.

- No splintering of the posterior cortex.

- No additional communication at the fracture site.

- Per-operatively in the early phase of learning curve, nail was broken during insertion, may be due to less obliquity of the entry site. In this case, fracture was minimally opened and exit of the broken nail which was caught in the distal fragment and reinsertion of fresh nail was done.

- In one patient with delayed healing, we attempted bone narrow aspiration through PSIS and simultaneous injection at the fracture site and achieved union

DISCUSSION

Most surgeons believe that intramedullary nailing is the best internal fixation for femoral and tibial shaft fractures, but there is no agreement about the ideal procedure for fractures of the humeral shaft. Plate osteosynthesis requires extensive dissection with the risk of radial nerve damage **(Rommens et al 1989)**[21]: this has been reported in 3% to 29% of cases in a prospective study in 12 German hospitals (**Nast-Kolb et al 1991**)[18]. Patient tolerance of external fixation is low: the pins perforate muscle bellies and pin – track infections are often seen (**Kamhin et al 1978). Ender nails, Rush pins and Kuntscher nails (Mackay 1984; Brumback et al 1986 : Hall and Pankovich 1987 : Rush 1987)** tend to displace and obstruct shoulder or elbow movement while their rotational stability is low. Hackethal nailing was once popular **(Hankethel 1961: Heimel and Okumusoglu 1979: Kocher and Ledermann 1980)**[7]**,** but gives insufficient stability and the implants may migrate **(Henning, Link and Wolfel 1988**).

The Seidel nail was specifically designed for humeral fractures **(Seidel 1989: Eberle et al 1992)** , but is too big for many medullary canals : reaming is always necessary. The insertion may be difficult and cause fractures **(Ruf and Pauly 1993)**. It can only be used by an anterograde technique **(Seidel**

1989 : Riemer et al 1991) which risks damage to the rotator cuff. Other problems are protrusion, lack of rotational stability and loosening of the distal fixation with risk of pseudarthrosis **(Robinson et al 1992**).

Our nail (Universal humeral nail-MODIFIED INDIAN VERSION OF **AO** NAIL) is smaller in diameter (6 to 6.7mm solid nail and has 5° proximal bend and is slightly curved both proximally and distally, while two locking screws give rotational stability. It can be inserted by either an anterograde or a retrograde approach which is totally extra-articular. As the nail is solid, insertion has to be carried out more carefully. It is important that the opening in the medullary canal is placed exactly in the centre of the triangle of the dorsal surface of the distal metaphysis, and is slightly higher than the level chosen by INGMAN and WATERS (1994) to avoid mechanical hindrance at the elbow. The opening has to be very oblique and has to be almost in line with the medullary canal, otherwise additional communition, or even supracondylar fracture can occur or the penetration of the anterior cortex can occur. Tip of the nail should not be more proximal than the surgical neck, so that the locking screw can be inserted without damage to the axillary nerve or the articular cartilage. After nail insertion, the distal wound must be thoroughly cleaned to avoid periarticular callus formation.

Our series of 19 carefully studied patients provided very positive experience. In our series, union rate was noted as 94.73% and average time in our series was 13.74 weeks. This is in comparison to some of the international studies, as following (4,5,6,12).

UNION RATE – IN RETROGRADE NAILING

P.M.Rommens : *J. Verbruggen :* *P.L. Broos* et al – 1995 **JBJS Br Vol 77(B)**	*P.M. Rommens :* *Blum. J.Runkel.M* et al **Clin. orthop** 1998 (190 cases of multicentre prospective study)	*Lin; Jinn; Hou.Shen Mou*; **Clin. Orthop** 1997 (342)	Our study
94.8%	**92.63%**	**100%**	**94.73%**

Our union rate is in comparison with the above international studies exclusive of retrograde nailing in humerus diaphyseal fractures.

SHOULDER & ELBOW FUNCTIONS – IN RETROGRADE NAILING

P.M.Rommens : *J. Verbruggen :* *P.L. Broos* et al – 1995 **J.B.J.S. Br Vol 77(B)**	*P.M. Rommens :* *Blum. J.Runkel.M* et al **Clin. orthop** 1998 (190 cases of multicentre prospective study)	Our study
Shoulder function Excellent 92.5%	**89.7%**	**89.47%**
Elbow function Excellent 87.3%	**88.3%**	**73.68%**

UNION RATE ON COMPARISON WITH OTHER MODES OF TREATMENT

Anterograde Nailing				
Crates.J series. **Clin.Orthop**. 1998	*Cox.M.A.* series **J.Orthop trauma** 2000	*Chapman J.R.* series **J.Orthop**. **trauma** 2000	*James P. STANNAR* series **JBJS** *Br. 2003*	**J. Orthopedics** 2005 2 (p) C^2
94.5%	**87.9%**	**89.0%**	**92.85%**	**91.89%**

Plating		**Conservative**	**Our series**
Journal of trauma, *injury* May 1998	*R.J. Brumback et al* **J.B.J.S** *Am.1986*	*A. Sarmiento et al* *J.B.Zagorski et al* **J.B.J.S** *Am. 2000*	
97.91%	**96.4%**	**87%**	**94.73%**

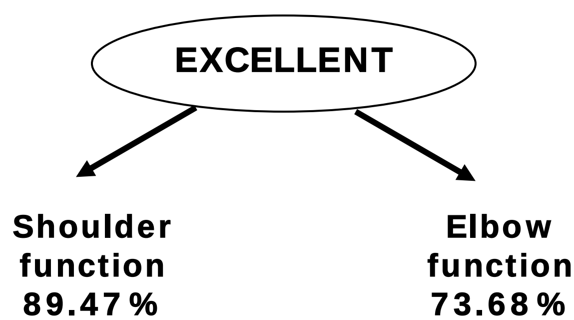
FUNCTIONAL OUTCOME : SHOULDER & ELBOW FUNCTION ON COMPARISON WITH OTHER MODES OF TREATMENT

Anterograde Nailing		
Brumbeck et al **J.B.J.S** *Am. 1986*	*Rodriguez Merahem EC* **J.Orthop Trauma** 1995;9;197-7	*Grates J. Whittle AP*. **Clin. Orthop** 1998;350 :40-50
Excellent – 64%	Excellent - 60%	Excellent- 90%

FUNCTIONAL OUTCOME (Contd)

Anterograde Nailing	Plating	Conservative	Retrograde Nailing
James.P; Stanner series **J.B.J.S.** 2003	*Linn, Jinn* series **Clin. Orthop** 1997	*A. Sarmiento J.B.Zagorski* et al **J.B.J.S** *Am. 2000*	*P.M.Rommen et al* series 1998
Shoulder function			
Excellent **76.19%**	**100%**	**60%**	**89.7%**
Elbow function			
Excellent **82.13%**	**99.4%**	**76%**	**88.3%**

Our Series



Sheerlink of Handelberg 2002 Jan (52) **Journal of trauma** 32 retrograde nailings compared with 22 Anterograde nailing quotes

"Retrograde approach resulted in better shoulder and elbow function than Anterograde nailing."

The functional results were satisfactory. Shoulder function recovered very rapidly, elbow function rather slower because of the dissection of the triceps tendon and muscle.

IATROGENIC RADIAL NERVE PALSY

PLATING		**ANTEROGRADE**		**RETROGRADE**
Bell et al 1985 **J.B.J.S.** *Br.*	*Brumbeck et al* **J.B.J.S** *Am. 1986*	*Lin; Jinn; Hou.Shen Mou*; **Clin. Orthop** 1997 (342)	*Grates J. Whittle AP*. **Clin. Orthop** 1998;350 :40-50	*P.M. Rommens : Blum. J.Runkel.M* et al **Clin. orthop** 1998 (190 cases of multicentre prospective study)
2.9%	**3.3%**	**2.09%**	**2.7%**	**4.2%**

Our Series 5.23%

In our series one case (5.2%) developed iatrogenic radial nerve palsy which recovered subsequently. This corresponds to the other international studies on locked nailing which show a rate of iatrogenic nerve injury between 0-5%[4,5,6]. This compares favourable with plate osteosynthesis which consistently has a higher rate of radial nerve palsy. Nail insertion requires great care, but we found the whole procedure less demanding than a plate and screw osteosynthesis. Healing was usually uneventful. It is one bone that needs collapse at the fracture site and this can be achieved by manual docking or by using specific compression device.

INFECTION

PLATING		**ANTEROGRADE**		**RETROGRADE**
Foster et al 1985 **J.B.J.S.** *Am.*	*Vander Griend et al* **J.B.J.S** *Br. 1986*	*Brumbeck et al* **J.B.J.S** *Am. 1986*	*Grates J. Whittle AP.* **Clin. Orthop** 1998;350 :40-50	*P.M.Rommens* : *J. Verbruggen :* *P.L. Broos* et al – 1995 **J.B.J.S. Br Vol 77(B)**
7%	**5.9%**	**3.3%**	**0%**	**0%**

In our study, no case developed infection (superficial or deep wound). This can be attributed to the lesser exposure time, smaller incision.

None of the cases developed axillary nerve deficits as a complication.

Better results were noted in more educated patients who took part in rehabilitation program with an active involvement.

CONCLUSION

This study was conducted to evaluate

1. **Radiological union**
2. **Functional outcome** in retrograde nailing of humerus shaft fracture

Our study had 94.73% of union rate and 91.8% of good to excellent results and 7.8% fair to poor results. Conservative treatment by ***A.Sarmiento et al*** gave lesser union rate and functional outcome whereas anterograde nailing by various international studies showed similar union rate but functional outcome was not favourable especially shoulder function and results are better by plating method. ***P.M. Rommens et al*** by retrograde nailing had results comparable to our study.

The concept of biological fixation in terms of unreamed nailing, closed reduction, static locking and fracture site compression promotes early and adequate fracture union.

The problem of shoulder impingement and peri-arthritis shoulder, rotator cuff injury in ante grade nailing are completely avoided with good functional outcome.

It helps in providing early rehabilitation and lessens the morbidity.

Retrograde humeral nailing is better than anterograde nailing and alternative to plate osteosynthesis for patients with indications for the operative treatment of fractures of the humeral shaft.

Retrograde nailing is an attractive option in polytrauma, for isolated fractures which would be difficult to treat conservatively and for patients who require a rapid functional recovery.

PROFORMA

NAME : AGE : SEX:

ADDRESS :

IP No : Unit : DOA : DOS : DOD :

WARD :

Mode of Injury Side of Injury R / L

Associated Injuries: Head / Abdomen / Pelvis / other limb injuries

A	A1	
	A2	
	A3	
B	B1	
	B2	
	B3	
C	C1	
	C2	
	C3	

A.O.Classification

Pre – operative complications – Radial nerve injury / Vascular injury

Investigation

- Plain X Ray AP and Lateral views
- Urine albumin / sugar
- Blood Hb /BT /CT / Urea / Sugar / Grouping and typing
- Chest X Ray
- ECG
- CT Brain

Initial Management : Improvement of General Condition

Closed reduction / ‘U’ slab

Details of other treatment particulars

SURGERY

- Interval between injury and surgery
- Patient position
- Duration of surgery
- Entry Portal
- Method of fracture reduction
- Length and diameter of nail
- Details proximal and distal locking

Complications

Per operative : Improper placement of nail splintering of entry site

Communition / distraction

Early Post operative – Infection

CLINICAL ASSESSMENT DURING FOLLOW UP

Sepsis / Shoulder pain / Shoulder and elbow range of movements

RADIOLOGICAL ASSESSMENT DURING FOLLOW UP

Callus appearance / Union time / Delayed union / Non – Union

0 6 weeks 12 months 6weeks 12 months

DETAILS OF SECONDARY PROCEDURES

FUNCTIONAL OUT COME

Excellent / Good / Fair / Poor

Follow up	6 wks	12 wks	6 Months	12 Months

Patient Name

(1) (2) (3) (4)

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